WHAT IS CLAIMED IS:

1. For use in acoustic micro imaging, a data memory containing data produced by interrogating a sample at three-dimensionally varied locations in the sample with a pulsed ultrasonic microscope probe, the data including for each location interrogated a digitized A-scan for that location.

2. The memory defined by claim 1 wherein said locations represent a series of X-Y planes displaced along the Z-axis of the probe.

3. The memory defined by claim 1 wherein the probed locations when excited are within the depth of field of a transducer producing the probe.

4. The memory defined by claim 2 wherein the said planes when probed are within the depth of field of a transducer producing the probe.

5. For use in acoustic micro imaging, a 4D virtual sample data memory storing a set of data for each of a number of acoustic impedance features within an actual sample interrogated by a pulsed ultrasonic microscope probe, the data set including for each of said impedance features a plurality of acoustic reflectance values resulting from excitations by said ultrasonic probe of different locations within said actual sample.

6. For use in acoustic micro imaging, a 4D virtual sample data memory storing a set of data for each of a number of acoustic impedance features within an actual sample interrogated by an X-Y scanned pulsed Z-axis ultrasonic microscope probe, the data set including for each of said impedance features a plurality of acoustic reflectance values resulting from excitations of Z-differentiated locations within said actual sample by said ultrasonic probe.

7. A 4D virtual sample data store containing data produced by a pulsed ultrasonic probe and representing for each point in an interrogated sample volume three spatial dimensions and a time variable, the time variable comprising a digitized time-varying waveform including characterizations of reflections from acoustic impedance features in the examined sample.

8. For use in acoustic micro imaging, a method for creating a 4D virtual sample data memory, comprising:

   a. employing a pulsed ultrasonic microscope probe to interrogate a sample at three-dimensionally varied locations in the sample;

   b. developing data produced by the pulsed microscope probe, the data including for each location interrogated a digitized A-scan for that location; and

   c. storing the developed data in a data memory.

9. For use in acoustic micro imaging, a method for creating a 4D virtual sample data memory, comprising:

   a. employing a pulsed ultrasonic microscope probe to interrogate a sample at three-dimensionally varied locations in the sample;

   b. developing data produced by the pulsed microscope probe, the data including for each location interrogated a digitized A-scan for that location;

   c. storing the developed data in a data memory; and

   d. accessing the data memory to retrieve and display said data.

10. For use in acoustic micro imaging, a method for creating a 4D virtual sample data memory, comprising:

   a. employing a pulsed ultrasonic microscope probe to interrogate a sample a plurality of times;

   b. developing a set of data for each of a number of acoustic impedance features within the sample interrogated by the pulsed microscope probe, the data set including for each of said impedance features a plurality of acoustic reflectance values resulting from excitations of different locations within the sample by the ultrasonic probe; and

   c. storing the developed data in a data memory.

11. The method defined by claim 10 wherein at least one stored reflectance value for each of said impedance features represents in-focus acoustic reflectance data.

12. The method defined by claim 10 wherein at least one stored reflectance value for each of said impedance features represents out-of-focus acoustic reflectance data.

13. The method defined by claim 10 wherein said plurality of stored reflectance values for each of said impedance features represent in-focus and out-of-focus acoustic reflectance data.

14. For use in acoustic micro imaging, a method for creating a 4D virtual sample data memory, comprising:

a. employing a pulsed ultrasonic microscope probe to interrogate a sample a plurality of times;

b. developing a set of data for each of a number of acoustic impedance features within the sample interrogated by the pulsed microscope probe, the data set including for each of said impedance features a plurality of acoustic reflectance values resulting from excitations of different locations within the sample by the ultrasonic probe;

c. storing the developed data in a data memory; and

d. accessing the data memory to retrieve reflectance values for said features and producing a display which exhibits acoustic impedance features.

15. The method defined by claim 14 wherein at least one stored reflectance value for each of said impedance features represents in-focus acoustic reflectance data.

16. The method defined by claim 14 wherein at least one stored reflectance value for each of said impedance features represents out-of-focus acoustic reflectance data.

17. The method defined by claim 14 wherein said plurality of stored reflectance values for each of said impedance features represent in-focus and out-of-focus acoustic reflectance data.

18. A method for generating and visualizing a 4D virtual sample data store, comprising:

a. with a pulsed ultrasonic probe, interrogating a sample a plurality of times with varying probe focus settings to develop data representing for each interrogated point in the sample three spatial dimensions and a time variable, the time variable comprising a digitized time-varying waveform characterizing reflections from acoustic impedance features in the examined sample; and

b. storing the developed data in a data memory.

19. A method for capturing space-time acoustic reflectance data characterizing impedance features in an X-Z plane of a sample interrogated with a pulsed ultrasonic probe oriented on a Z axis, comprising:

a. deriving for each of a plurality of locations in the X-Z plane a digitized non-peak-detected time-varying acoustic reflectance signal uniquely associated with each location; and

b. storing the signals.

20. A method for capturing space-time acoustic reflectance data characterizing acoustic impedance features in an X-Z plane of a sample interrogated with a pulsed ultrasonic probe oriented on a Z axis, comprising:

a. deriving for each of a plurality of locations in the X-Z plane a digitized non-peak-detected time-varying acoustic reflectance signal uniquely associated with each location, the probe being refocused as necessary to be in focus at each location; and

b. storing the signals.

21. A method for capturing 4D space-time acoustic reflectance data to create a virtual sample volume or spaced virtual sample layers which characterize impedance features in a sample volume interrogated with a Z-axis pulsed ultrasonic probe, comprising:

a. deriving and storing a digitized non-peak-detected time-varying reflection signal for each location in a series of locations in a first plane of the sample volume; and

b. deriving and storing a digitized non-peak-detected acoustic signal for each location in a series of locations in a second plane of the sample volume, said second plane being displaced from said first plane.

22. The method defined by claim 21 wherein said first plane is the X-Y plane.

23. The method defined by claim 21 wherein said first plane is the X-Z plane, Y-Z plane, or other Z plane.

24. The method defined by claim 21 wherein the focus setting is changed before the second plane is interrogated.

25. The method defined by claim 21 wherein the gain is adjusted before the second plane data is stored.

26. A method for capturing 4D space-time acoustic reflectance data to create a virtual sample volume or spaced virtual sample layers which characterize impedance features in a sample volume interrogated with a pulsed ultrasonic probe oriented along a Z axis, comprising:

a. deriving for each of a predetermined plurality of x,y locations in an X-Y plane a non-peak-detected digitized time-varying acoustic reflection signal uniquely associated with each location; and

b. at selected ones of said predetermined plurality of x,y locations, deriving additional acoustic reflection signals for different z-value locations.

27.A method for capturing space-time acoustic reflectance data to create a virtual sample volume or spaced virtual sample layers which characterize impedance features in a sample volume interrogated with a pulsed ultrasonic probe oriented along a Z axis, comprising:

a. deriving for each of a predetermined plurality of x,y locations in an X-Y plane, with the probe focused at or near the X-Y plane, a non-peak-detected digitized time-varying acoustic reflection signal uniquely associated with each location; and

b. at selected ones of said predetermined plurality of x,y locations, deriving additional acoustic reflection signals for different z-value locations, with the probe being refocused at or near at least selected ones of the Z-value locations.

28.The method defined by claim 27 wherein the deriving operations are caused to acquire reflectance data in the sample preferentially in a three-dimensional region of interest.

29.For use in an acoustic imaging microscope having a pulsed ultrasonic probe and a probe translation stage for translating the probe on X-Y-Z axes to scan a sample, a method for capturing 4D space-time virtual sample data characterizing acoustic impedance features in an examined volume of a sample interrogated with the pulsed ultrasonic probe, comprising:

a. scanning a first plane in the sample;

b. storing a digitized, non-peak-detected, time-varying acoustic reflectance signal for each interrogated point in the plane;

c. scanning a second plane in the sample;

d. storing a digitized, non-peak-detected, time-varying acoustic reflectance signal for each interrogated point in the second plane; and

e. repeating the scanning and storing operations to capture space-time data representing a virtual sample volume corresponding to the examined sample volume.

30. The method defined by claim 29 including controlling the focus of the probe during each scanning operation such that each of the interrogated planes are in focus when scanned.

31. The method defined by claim 29 wherein the scans are made successively in planes displaced in the direction of the probe, and including causing the displacement of the scans to be substantially equal to the depth of field of the probe.

32. The method defined by claim 29 wherein the scans are made successively in planes displaced in the of the probe, and including causing the displacement of the scans between planes to be greater than the depth of field of the probe to create an underscan condition.

33. The method defined by claim 29 wherein the scans are made successively in planes displaced in the direction of the probe, and including causing the displacement of the scans to be less than the depth of field of the probe to create an overscan condition.

34. The method defined by claim 29 including amplifying the stored data and modulating a display with the stored data, and further including adjusting the amplification of the data stored to compensate the display for known variances in acoustic reflectance signal amplitude.

35. The method defined by claim 29 including changing the amplification of the signal at each scanned plane in the sample prior to digitization of the signal.

36. The method defined by 34 wherein the amplitude is adjusted to compensate the display for attenuation of acoustic energy by the sample.

37. The method defined by claim 36 including changing the amplification of the signal at each scanned plane in the sample prior to digitization of the signal.

38. The method defined by claim 29 wherein the scans are made successively in X-Y planes displaced in the Z direction of the probe, and at least one of the points in the successive planes has the same "x,y" value, but different "z" values such that multiple acoustic reflectance signals are stored for the same value of "x,y".

39. The method defined by claim 29 wherein the multiple acoustic reflectance signals are retrieved and processed together to develop new acoustic reflectance information.

40. For use in a scanning acoustic microscope having a pulsed ultrasonic probe on a Z axis and a probe translation stage for translating the probe in an X-Y plane of a sample, a method for capturing space-time virtual sample data characterizing acoustic impedance features in multiple scans of a sample interrogated with the pulsed ultrasonic probe and producing an X-Y plane display of predetermined acoustic reflectance fidelity, comprising:

a. determining the desired level of acoustic reflectance fidelity by dividing the thickness of the sample Z-depth to be examined by the desired depth resolution to derive a quotient “q”;

b. selecting a probe having a depth of field no greater than the desired depth resolution;

c. scanning the probe in the X-Y plane along first series of inspection points;

d. sensing and storing a digitized, non-peak-detected, time-varying acoustic reflectance signal for each interrogated point in the X-Y plane;

e. repeating the X-Y plane scanning, sensing, and storing operations for successive “z” values to a total of “q” times;

f. adjusting the location of the depth of field of the probe during each such operation such that successive portions of the sample are within the probe depth of focus when the acoustic reflectance signals are stored;

g. for each of specific values of “x,y” in the X-Y plane, retrieving the stored acoustic reflectance signals for “q” different values of “z”, and eliminating the stored acoustic reflectance signals that do not correspond to Z-depths in the sample substantially equal to the depth of field of the probe;

i. for each such specific values of "x,y", effectively joining in-focus acoustic reflectance signal segments from adjacent "z" values in the sample to produce a synthesized optimally scanned A-scan , all parts of which represent in-focus acoustic reflectance data;

j. retrieving the stored synthesized composite acoustic reflectance signals for all values of "x,y,z" in the examined sample; and

k. employing the synthesized composite signals to modulate a display exhibiting only acoustic reflectance data from in-focus impedance features.

41. The method defined by claim 40 wherein the composite signals are amplified before being stored, and wherein the amplification is adjusted to compensate the display for known variances in signal amplitude.

42. The method defined by claim 40 including adjusting the amplification of the signal at each scanned plane in the sample prior to digitization of the signal.

43. The method defined by claim 41 wherein the amplification is adjusted to compensate for attenuation of acoustic energy by the sample.

44. The method defined by claim 43 including adjusting the amplification of the signal at each "z" value prior to digitization of the signal.

45. The method defined by claim 40 including suppressing discontinuities created by joining in-focus acoustic reflectance signal segments.

46. The method defined by claim 45 wherein discontinuities are suppressed by low-pass filtering, high-pass filtering or a combination of low-pass and high-pass filtering.

47. For use in a scanning acoustic microscope having a pulsed ultrasonic probe and a probe translation stage for translating the probe at three-dimensionally varied locations in a sample, a method for capturing space-time virtual sample data characterizing acoustic impedance features

in multiple scans of a sample interrogated with the pulsed ultrasonic probe and producing a display of predetermined acoustic reflectance fidelity, comprising:

a. determining the desired level of acoustic reflectance fidelity by dividing the thickness of the sample to be examined along the axis of the probe by the desired depth resolution to derive a quotient “q”;

b. scanning the probe along a first series of inspection points;

c. sensing and storing a digitized, non-peak-detected, time-varying acoustic reflectance signal for each interrogated point in the first series of inspection points;

d. repeating the scanning, sensing, and storing operations for successive positions of the probe along its axis to a total of “q” times;

e. adjusting the location of the depth of field of the probe during each such operation such that successive portions of the sample are within the probe depth of focus when the acoustic reflectance signals are stored;

f. for each of specific values of the two spatial dimensions other than along the probe axis, retrieving the stored acoustic reflectance signals for “q” different values of the probe position along its axis, and eliminating the stored acoustic reflectance signals that do not correspond to depths in the sample substantially equal to the depth of field of the probe;

g. for each such specific values of the non-probe axis dimensions, effectively joining in-focus acoustic reflectance signal segments from adjacent probe positions along the probe axis to produce a synthesized optimally scanned A-scan , all parts of which represent in-focus acoustic reflectance data;

h. retrieving the stored synthesized composite acoustic reflectance signals for all three dimensionally varied locations in the examined sample; and

i. employing the synthesized composite signals to modulate a display exhibiting only acoustic reflectance data from in-focus impedance features.

48. The method defined by claim 47 wherein the composite signals are amplified before being stored, and wherein the amplification is adjusted to compensate the display for known variances in signal amplitude.

49. The method defined by claim 47 including changing the amplification of the signal at each of said successive positions of the probe along its axis prior to digitization of the signal.

50. The method defined by claim 48 wherein the signal amplification is adjusted to compensate for attenuation of acoustic energy by the sample.

51. The method defined by claim 50 including adjusting the amplification of the signal at each probe position along its axis prior to digitization of the signal.

52. The method defined by claim 47 including suppressing discontinuities created by joining in-focus acoustic reflectance signal segments.

53. The method defined by claim 52 wherein discontinuities are suppressed by low-pass filtering, high-pass filtering or a combination of low-pass and high-pass filtering.

54. For use in a scanning acoustic microscope having a pulsed ultrasonic probe and a probe translation stage for translating the probe at three-dimensionally varied locations in a sample, a method for capturing space-time virtual sample data characterizing acoustic impedance features in multiple scans of a sample interrogated with the pulsed ultrasonic probe and producing a display of predetermined acoustic reflectance fidelity, comprising:

a. determining the desired level of acoustic reflectance fidelity by dividing the thickness of the sample to be examined along the axis of the probe by the desired depth resolution to derive a quotient "q";

b. scanning the probe along a first series of inspection points;

c. sensing a digitized, non-peak-detected, time-varying acoustic reflectance signal for each interrogated point in the first series;

d. eliminating the acoustic reflectance signals that do not correspond to depths in the sample substantially equal to the depth of field of the probe and storing the remaining signals;

e. repeating the scanning, sensing, eliminating and storing operations for successive positions of the probe along its axis to a total of "q" times;

f. adjusting the location of the depth of field of the probe during each such operation such that successive portions of the sample are within the probe depth of focus when the acoustic reflectance signals are stored;

g. for a number of such specific values of the non-probe axis dimensions, effectively joining in-focus acoustic reflectance signals segments from adjacent probe positions along the probe axis to produce a synthesized optimally scanned A-scan, all parts of which represent in-focus acoustic reflectance data;

h. retrieving the stored synthesized composite acoustic reflectance signals for all of the three-dimensionally varied locations in the examined sample; and

i. employing the synthesized composite signals to modulate a display exhibiting only acoustic reflectance data from in-focus impedance features.

55. The method defined by claim 54 wherein the composite signals are amplified before being stored, and wherein the amplification is adjusted to compensate the display for known variances in signal amplitude.

56. The method defined by claim 54 including changing the amplification of the signal at each of said successive positions of the probe along its axis.

57. The method defined by claim 55 wherein the amplification is adjusted to compensate for attenuation of acoustic energy by the sample.

58. The method defined by claim 57 including changing the amplification of the signal at each position of the probe along its axis prior to digitization of the signal.

59. The method defined by claim 54 including suppressing discontinuities created by joining in-focus acoustic reflectance signal segments.

60. The method defined by claim 59 wherein discontinuities are suppressed by low-pass filtering, high-pass filtering or a combination of low-pass and high-pass filtering.

61. The 4D virtual sample data store defined by claim 7 wherein the amplitude of the digitized time-varying waveform has been adjusted to compensate for attenuation losses within the sample.